SCIENCE INVESTIGATIONS AND EXPLORATION IN CELESTIAL MAPPING SYSTEM

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Introduction

Celestial Mapping System (CMS) is a software platform to generate virtual 3D globes for celestial bodies. Various layers are built on top of the virtual globe to provide visualization of high-resolution imagery, enable precise measurements, build analytical capabilities and provide a broad range of functionalities. Users can perform equipment planning and optimized placement on Lunar surface, line of sight analysis to inform the coverage area for various equipment. In addition, CMS provides powerful measurement tools based on 3D terrain, 3D COLLADA models to represent rovers, humans and equipment, visualization of derived mapping products (e.g. resource maps), and a data engine for hosting new observations that are not available in other contemporary lunar data tools [1,2].

Visualization of PSRs

In CMS we are able to ingest a unique dataset of super-enhanced images of the permanently shadowed regions (PSRs) at the lunar poles which were produced by the Hyper-effective nOise Removal U-net Software (HORUS) tool [3]. This tool was developed in direct support of NASA's VIPER and Artemis programs to enhance the extremely low-light images of the interior of PSRs and provide the first-time ability to see within these regions at and discern surface features (i.e. boulders and craters) down to 3 meters in size [Fig 1,2]. We focused on the region near Nobili crater near Lunar south pole, selected site for VIPER mission and stitched several images to create a high-resolution map within one of the PSR of Nobile crater as shown in Fig 3.

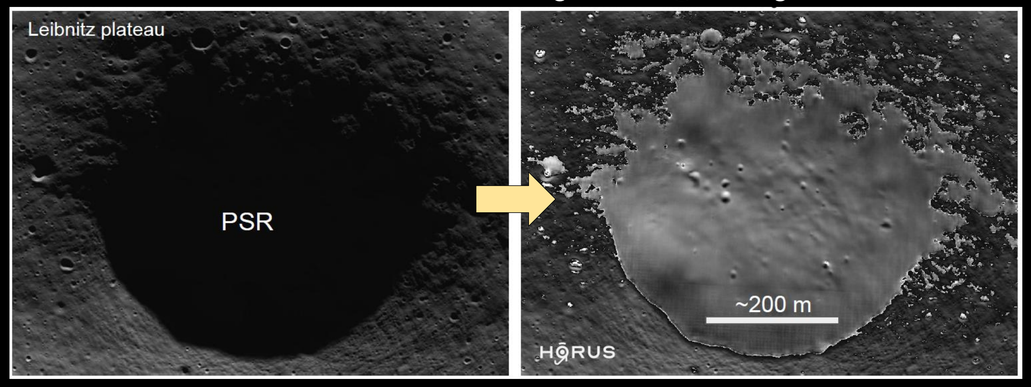

Fig 1: NASA LRO - NAC image of a PSR

Fig 2: HORUS enhanced image clearly revealing features within the PSR

Fig. 3 Visualization of PSR in Nobili crater region within CMS

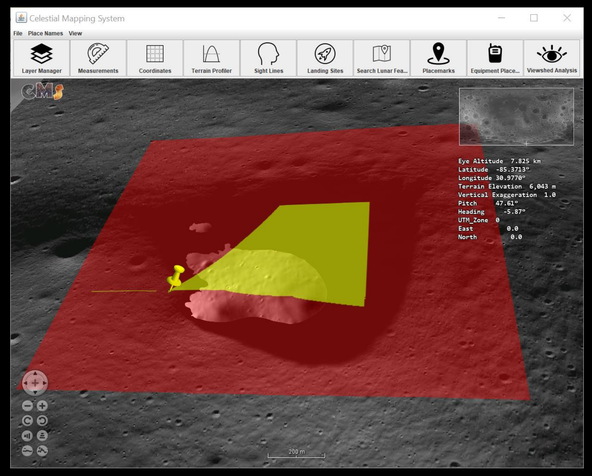

Fig. 4 Viewshed Analysis of a remote observer (yellow pin), visible portion is shown in yellow

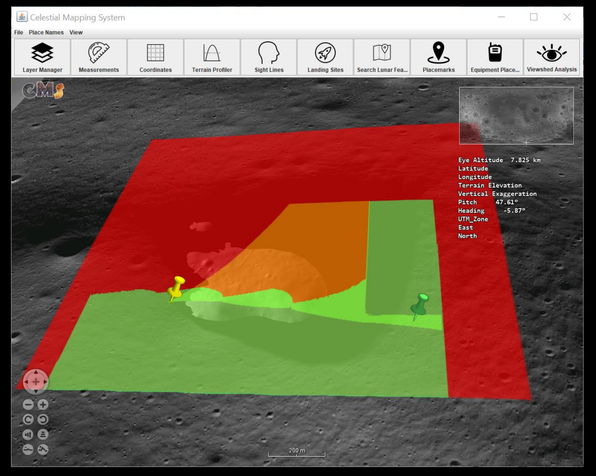

Fig. 5 Viewshed Analysis of multiple remote observers, visible portion shown in respective colors of the pins (observers)

Line of Sight Analysis and Traverse Planning in PSRs:

We have developed an in-built line of sight analysis (LOS) tool in CMS that analyzes the terrain profile and obstructions and provides the visibility of a given terrain for a remote observer. We performed viewshed analysis to investigate the visibility of a remote observer within the PSR. This analysis was further extended to set different heights for various observers as shown in Fig 4 and Fig 5. Combining the different visibility profiles can help designing improved traverses within the crater.

Future Plans:

HORUS datasets will be integrated into CMS as a layer in selected lunar polar regions. Hazard Maps will then be created based on terrain analysis in those regions. This integration will enable multiple scientific and exploration applications, such as designing traverses within PSRs, analyzing potential landing and science mission targets, investigating the meter-scale geomorphology of PSRs, including craters, boulder, surface roughness.

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[3] Bickel V. et al. (2021) Nat Commun 12, 5607

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